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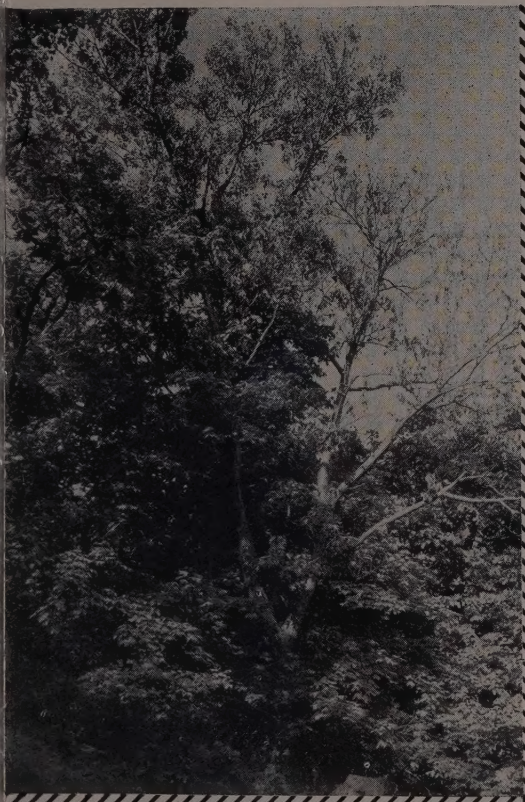
OAK WILT

a serious disease in Iowa



Agricultural Experiment Station–Agricultural Extension Service
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SUMMARY

In the past 5 years wilt has come to be recognized as the most important oak disease in the upper Mississippi valley. The disease has been reported from Iowa, Wisconsin, Minnesota, Missouri and Illinois. The fungus *Chalara quercina* Henry has been shown definitely to be the cause of the disease.

Trees of the red oak group are killed quickly, usually within 30 to 60 days after wilt symptoms are apparent. Those of the white oak group may survive several years after infection with only a few branches being killed each year.

All types of oak apparently are susceptible since all of the 28 species inoculated in the greenhouse were infected. The disease has been found on 9 of the 11 native species in Iowa.

Infected trees have not been observed to recover from oak wilt. Prevention of spread of the disease has been attempted by various methods of sanitation. In general, removing diseased trees as soon as symptoms appear has been effective in stopping or retarding spread in state park and state forest test areas. Pruning experiments on trees that had only a few infected branches indicate that white oaks may often be saved by removal of such infected branches at a point well back of the latest symptoms.

Frost injury, leaf blight and insect and rodent injury often result in leaf discoloration which from a distance may be mistaken for oak wilt.

Oak Wilt—A Serious Disease in Iowa[1]

By S. M. Dietz and Roy A. Young[2]

A disease of oaks, particularly severe on red and black species, has been observed in the upper Mississippi valley for many years. Some qualified woodsmen recall having seen the disease in Iowa as long as 30 years ago. Photographs leave no doubt that it was present in 1932 in the area around McGregor. The complete removal of dead and dying trees by the Civilian Conservation Corps in the period 1933 to 1936 undoubtedly reduced the losses. By 1943, however, the disease had reached such serious proportions in northeastern Iowa and in Dolliver and Pilot Knob state parks that intensive investigations were begun to determine the cause and control.

The death of the trees had been attributed to various agencies such as insects and drouth. In 1942 investigators at the University of Wisconsin proved that the disease was due to a fungus that invades the tree, causes a wilting of the leaves and ultimately kills the tree. This fungus was named *Chalara quercina* by B. W. Henry in 1944. Isolation of the fungus from dying oak trees has since been reported from Illinois, Iowa, Minnesota, Missouri and Wisconsin, and the fungus has been definitely established as the cause of the disease known as oak wilt.

SYMPTOMS

The symptoms of oak wilt vary with the kind of oak and the season of the year in which initial infection occurs. The symptoms on the two major groups, the red oaks and the white oaks, are so different that they can best be described separately.

The first evidence of the disease on a red or black oak is apparent in the uppermost leaves of the crown or the outermost leaves of the lateral branches. These leaves become dull, light green in color, and curl or cup upward slightly. Later they turn

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[1] Project 876 of the Iowa Agricultural Experiment Station, conducted cooperatively with the Iowa State Conservation Commission.

[2] Formerly Research Professor of Plant Pathology and Industrial Fellow, respectively. The writers wish to acknowledge with thanks the assistance of Messrs. V. W. Flickinger and W. A. Rush, Chief of the Division of Lands and Waters, and State Superintendent of Parks, respectively, of the Iowa State Conservation Commission.

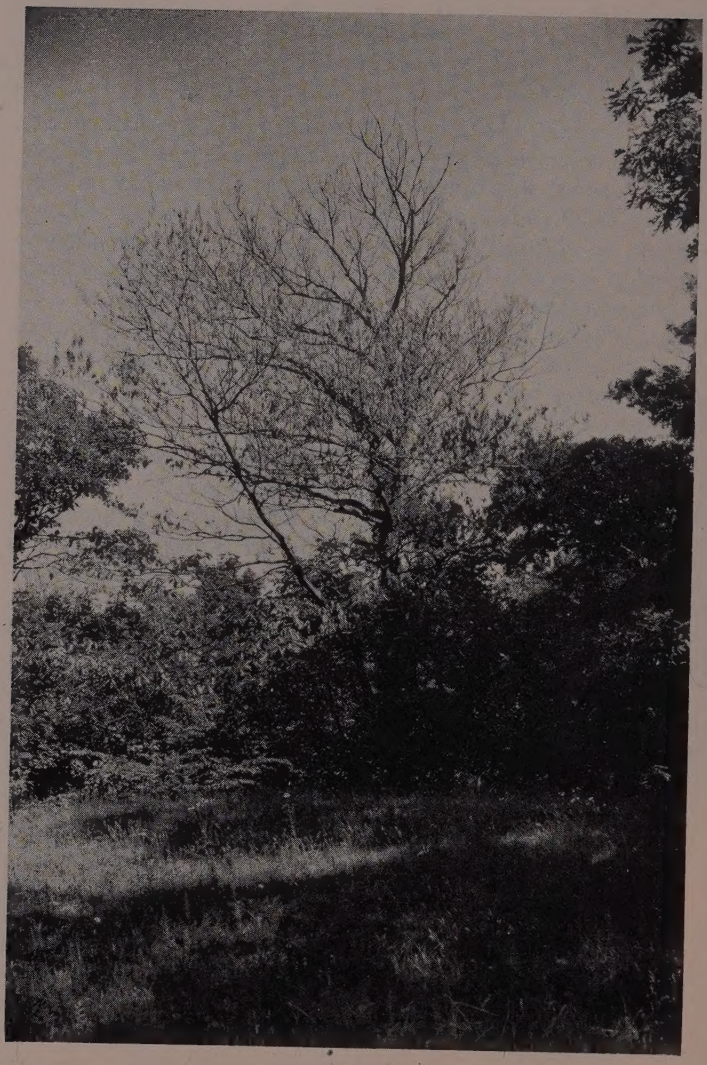


Fig. 1. Red oak tree at Dolliver State Park, showing progressive defoliation from top downward. Photographed 2 weeks after the first symptoms of wilt appeared.

bronze or reddish brown and fall from the tree (fig. 1). The disease progresses downward and inward very rapidly. The tree may be completely defoliated in 2 to 4 weeks. At this stage the bare or partially defoliated branches are very conspicuous (fig. 2.)

External symptoms are usually accompanied by brown discoloration in the region of the cambium. If twigs or branches from the diseased trees are split longitudinally, dark brown streaks running lengthwise may be found at the junction of the bark and wood and in the outer sapwood.

When trees are infected late in the fall, leaf development is retarded the following spring and only a few scattered small leaves appear on the tree. Red oak trees that are infected early in the season are usually completely dead 30-60 days after the first symptoms of wilt become apparent.

The symptoms on bur and white oaks are much more localized than in the red oaks as a result of the slow progress of the disease. The first symptoms may appear on branches on any part of the tree though they occur most commonly on apical branches. The leaves of infected branches may become wilted and yellow and eventually drop, while leaves on the remaining branches of the tree apparently remain healthy. The current year's twig growth on infected branches often takes on a bronzed color and becomes brittle at the base. This localized infection and killing often results in a stag-headed appearance in white and bur oak (fig. 3). These trees may remain infected over a period of several years with only a few branches being killed each year.

CAUSE OF OAK WILT

The fungus *Chalara quercina* has definitely been proved to be the cause of the disease known as oak wilt in Iowa. This fungus produces a branched, greenish-brown mycelium from which chains of colorless, rod-shaped, single celled endospores are produced. An odor similar to that of fermenting apples is produced by the organism in culture.

Chalara quercina has been isolated from the blade, midvein and petiole of leaves; from the twigs, branches and bole; and from the roots. It is found most commonly in the region just below the bark in twigs and branches. In the bole the fungus seldom penetrates the wood more than ¼ inch. The fungus invades red oaks very rapidly. In one test where it was inoculated into

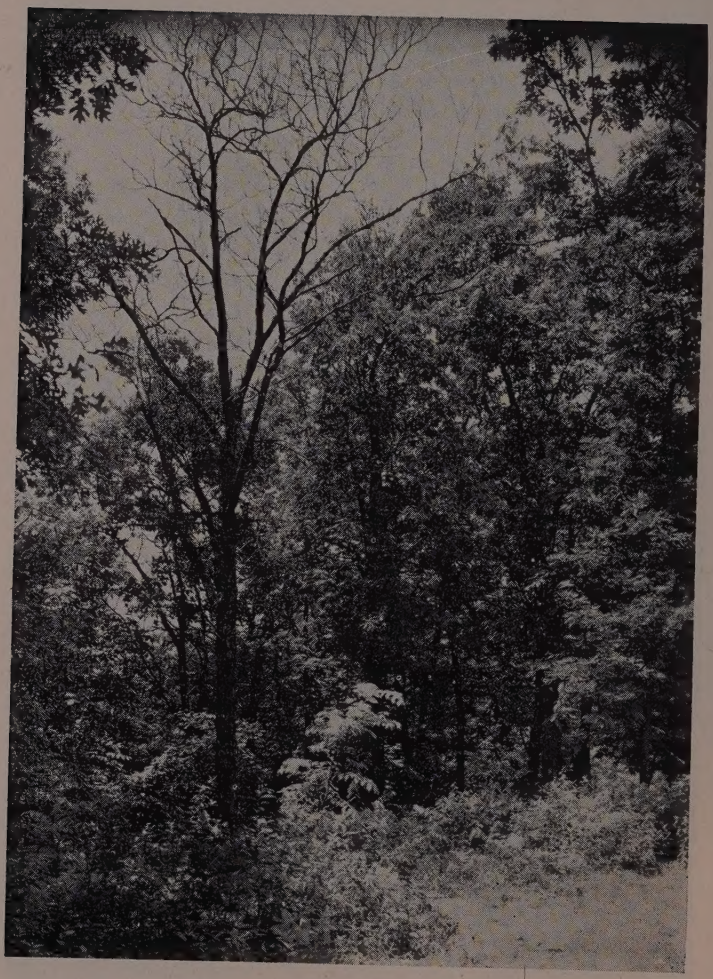


Fig. 2. Defoliated red oak. Photographed 5 weeks after symptoms first appeared.

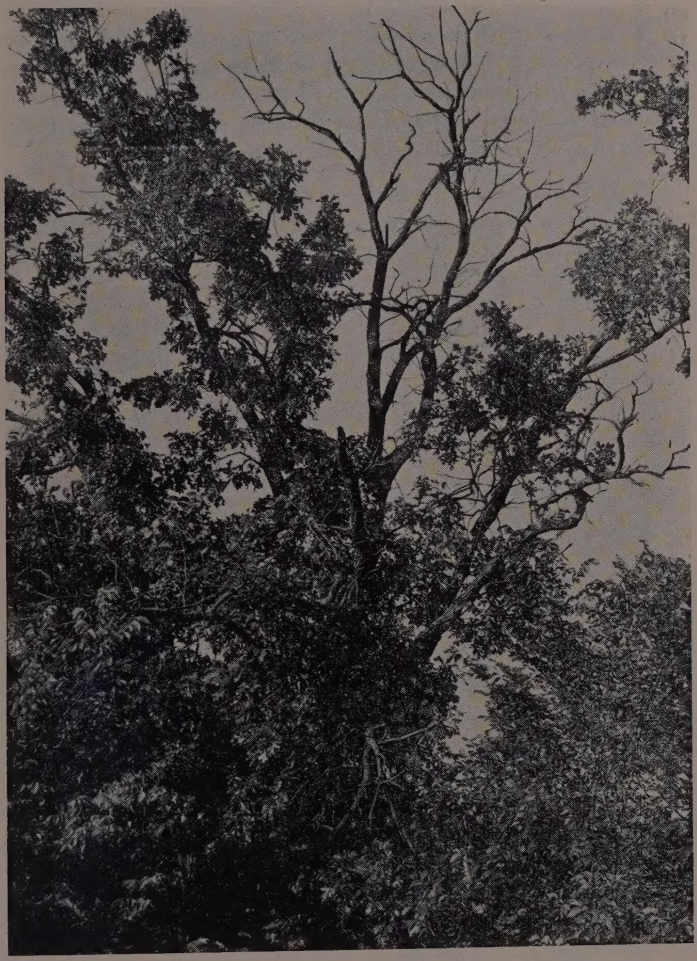


Fig. 3. Stag-headed bur oak. The wilt organism frequently is associated with localized killing of this type.

the base of the bole of a 53-foot red oak tree it was recovered from the uppermost twigs at the end of 60 days.

HOST RANGE

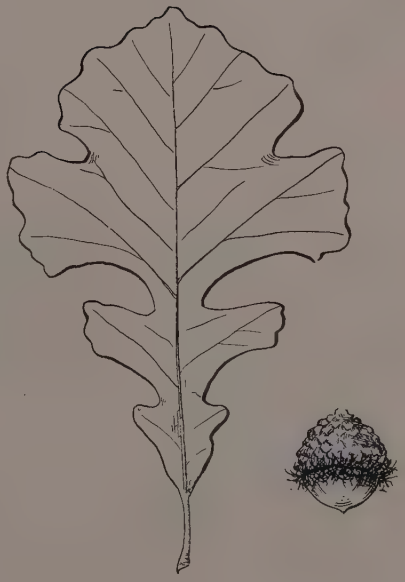
As a possible means of controlling or combating oak wilt, numerous species of oak were tested for resistance to the wilt fungus. Tests were first made on the 11 species of oak considered to be native to Iowa. These oaks, grouped into their two major groups, may be identified by the following characteristics.

WHITE OAK GROUP—Bark on trunk and old branches pale, often scaly, on young branches gray and rough, leaves with rounded lobes, inside surface of acorn shell smooth, acorns maturing in 1 year.

1. *Quercus alba*—WHITE OAK
Leaves oblong, cut into 5–9 oblong lobes, bright green on upper surface, pale, smooth on lower surface. Acorn cup rough, much shorter than the acorn. Acorn ¾ inch long. Distribution general over eastern two-thirds of Iowa.

2. *Q. bicolor*—Swamp White Oak.
Leaves narrower at base than at tip, shallow lobes, shiny green on upper surface, white, hairy on lower surface. Cup ⅓ to ½ as long as the acorn. Acorn about 1 inch long. Occurs along streams and in swamp land in eastern half of the state.

3. *Q. macrocarpa*—Bur Oak.
Leaves large, broad at tip, narrow at the base, dark green, shiny on upper surface, lower surface pale and hairy. Twigs with thickened corky ridges. Cup deep, conspicuously fringed on the margin, enclosing most of the acorn. Acorn ½ to 1½ inches long. Distributed generally over the state.



4. *Q. muehlenbergii*—Chinquapin Oak.
Leaves oblong, often pointed, coarsely toothed, thick, greenish yellow above, pale hairy below. Cup thin, enclosing about one-half of nut. Acorn about ¾ inch long. Distributed over southeastern half of state. Not generally distributed, usually locally abundant.

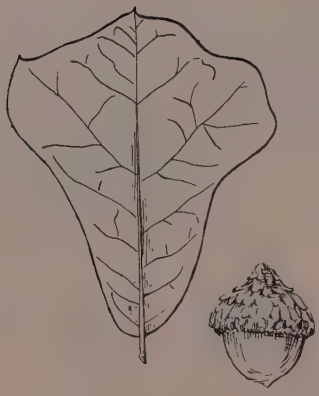
5. *Q. stellata*—Post Oak.
Leaves thick, cut into 5-7 wide rounded lobes, dark green and rough above, grayish or brownish downy underneath. Acorn ½ inch long. Found in extreme southeastern Iowa.

RED OAK GROUP— Bark on trunk and old branches dark, furrowed, on young branches smooth, dark green, shiny, leaves with sharp bristle-pointed lobes, inner surface of acorn shell woolly acorns requiring 2 years to mature.

6. *Q. borealis*—RED OAK.
Leaves thin, 5-11 lobed, dull green above, paler green beneath. Inner bark light red and not bitter. Large acorn, 1 inch long with shallow flat cup. Distribution general over the state.

7. *Q. ellipsoidalis*—HILL'S YELLOW OAK.
Leaves thin, smooth, lobes 5-7, deep and rounded, bright green above, paler beneath. Inner bark yellow. Small black striped acorn ½-¾ inch long, deeply saucer shaped cup which covers one-third to more than one-half of acorn. Distributed over eastern two-thirds of the state.

8. *Q. imbricaria*—Shingle Oak.
Leaves elongate, not lobed, shiny dark green above, pale hairy beneath. Acorn small, ½ inch long, cup covering one-half of nut. Occurs chiefly in southeastern quarter of state.



9. *Q. marilandica*—Blackjack Oak.
Leaves thick and leathery, narrow at base, tip broad, three lobed, dark green above, yellow hairy beneath. Acorn ¾ inch long, half covered by large scaled cup. Occurs in southeastern Iowa.

10. *Q. palustris*—Pin Oak.
Tree branching horizontally, cone shaped, leaves thin, 5-7 deep lobes, dark green above, paler green beneath. Cup flat, saucer shaped, acorn rounded, ½ inch in diameter. Distribution general along Mississippi River and across the southern one-sixth of the state.

11. *Q. velutina*—Black Oak.
Leaves thick and leathery, usually 7 lobed, dark green above, pale hairy below, with yellow petiole. Inner bark thick, yellow and very bitter. Acorn ½ to ¾ inch long, often hairy, half enclosed in cup. Distribution general over state except in western central portion.

These 11 species of oak native to Iowa were all shown to be susceptible to oak wilt. Of the native species the following nine were found naturally infected in the field: *Quercus alba* (White Oak), *Q. borealis* (Red Oak), *Q. ellipsoidalis* (Hill's Yellow Oak), *Q. imbricaria* (Shingle Oak), *Q. macrocarpa* (Bur Oak), *Q. marilandica* (Blackjack Oak), *Q. muehlenbergii* (Chinquapin Oak), *Q. palustris* (Pin Oak) and *Q. velutina* (Black Oak). The remaining species were shown by greenhouse inoculation with the causal organism to be susceptible to oak wilt.

In looking further for a resistant oak, the following 17 species, not native to Iowa, were also tested by inoculation in the greenhouse: *Quercus coccinea* (Scarlet Oak), *Q. falcata* (Southern Red Oak), *Q. falcata* var. *pagodaefolia* (Swamp Red Oak), *Q. gambelii* (Gambel Oak), *Q. garryana* (Oregon White Oak), *Q. hemisphaerica, Q. laevis* (Turkey Oak), *Q. laurifolia* (Laurel Oak), *Q. montana* (Chestnut Oak), *Q. nigra* (Water Oak), *Q. phellos* (Willow Oak), *Q. prinus* (Basket Oak), *Q. robur* (English Oak), *Q. shumardii* (Shumard Oak), *Q. shumardii* var. *texana* (Texas (Red Oak), *Q. suber* (Cork Oak) and *Q. virginiana* var. *maritima* (Live Oak). The fungus became established in all 17 species and invaded the stem for considerable distance. Typical symptoms of wilt were observed on the leaves and the fungus was reisolated, so it was concluded that all 28 species were susceptible.

ECONOMIC IMPORTANCE

Oak wilt is distributed in the oak forests and woodlots of Illinois, Iowa, Minnesota, Missouri and Wisconsin. It is particularly severe in northeastern Iowa and southeastern Minnesota. Since there are no known resistant species of oak, the economic importance of oak wilt would be influenced by the percentage of oak trees in wooded areas and the number of trees dying from oak wilt.

In 1945, data were obtained from 45 woodlots in northeastern Iowa with a total area of 1,933 acres. In these lots 51 percent of the total trees belonged to the red oak group and these trees contributed 58 percent of the volume per acre. In one 40-acre woodlot, sufficient trees were killed by oak wilt to constitute 69 percent of the potential annual growth of all trees. In farm woodlots near Dubuque, 25 percent of the oak trees were killed by wilt. In representative areas in Pilot Knob State Park where 85 percent

of the trees were Hill's yellow oak, 51 percent had been killed by oak wilt.

In Wisconsin, oak trees comprise about 80 percent of the stand of trees in southern, southwestern and western parts of the state. From 1929 to 1939 the annual sale of lumber varied from 10 to 17 million dollars and the average annual sale of oak lumber averaged 5½ million dollars. These figures do not include trees in municipal, county, state or federal parks or in private lawns where their aesthetic value is difficult to estimate.

Much of the regeneration on cut-over oak land is by growth of sprouts from stumps. This method is retarded in infected bur and white oaks and prevented in red oaks since the tree is completely killed and there is no living tissue from which stump sprouts may develop. If stump sprouts do develop before the tree is completely dead, they are short-lived, as the wilt organism will pass from the stump into the new sprouts and kill them.

Oak wilt probably is the most important disease of oak species in the upper Mississippi valley.

CONTROL

No satisfactory method of controlling oak wilt has been found. All species of oak tested have proved susceptible to attack by the wilt-producing organism. Of the methods of control studied, various forms of sanitation have yielded the most promising results.

Tests made in Dolliver State Park showed that infected areas could be cleaned up. Two isolated centers of infection were carefully mapped. The infected trees were removed and all red oaks within 50 to 100 feet of the diseased trees were cut down. The logs were hauled away and all oak brush, broken branches, chips, etc., were burned. None of the trees remaining in these two areas have become infected during the 3 years that have elapsed since this sanitation program was carried out.

Less drastic attempts at control in which only the dead and diseased oaks in an area were removed have generally eliminated or retarded the disease.

The pruning of infected limbs of bur and white oaks at a point 3 to 4 feet back of the symptoms has in several instances been effective in saving individual trees. However, results from pruning have not been consistent, and pruned trees must be closely observed for further expression of symptoms.

On the basis of field experimental results the following recommendations for control are made.

1. Remove red oaks as soon as the first symptoms of the disease are apparent. In removal fell the trees carefully to avoid injuring other oak trees and thus transmitting the disease. Peel the bark from the stump, burn all small branches and leaves, slab the logs and burn the slabs. The brush should be piled on the stump and burned, or if the stump cannot be burned without injury to other trees, the stump should be painted with creosote or oil. Care should be taken not to pile logs from diseased trees against the boles of healthy oak trees.

2. Remove woodlot white and bur oaks as soon as the first symptoms of wilt appear, observing the same precautions as for red oak.

3. White and bur oaks that show symptoms on only one or two isolated branches may often be saved by pruning or topping. If especial value is attached to a tree, the following procedure may be carried out. Remove the infected branch or branches at a point 3 to 4 feet (more, if possible without ruining the tree) below the most advanced symptoms, and burn all removed parts. Take care not to injure branches of other trees with infected branches. The tree should be examined periodically, and if further symptoms appear, either prune more severely or remove the tree.

4. In farm woodlots infected trees should be removed as soon as possible. If they cannot be removed immediately, due to the pressure of other duties during the summer, they should be marked for removal during the winter.

OTHER COMMON OAK DISEASES AND INJURIES

In the field several other types of killing and injury on oak may be confused with the wilt produced by *Chalara quercina.*

1. Frost injury often results in the death of young leaves in early spring. The most severe killing occurs at the top of the tree where injured leaves appear brown and curled. Dormant buds are forced and new leaves are normally formed by the frosted tree in a few weeks.

2. Oak leaf blight (Anthracnose, Sycamore blight) has been severe on white and bur oak over most of Iowa during the past 3 years. This disease may be distinguished from oak wilt and from

frost injury by the fact that initial infection and killing are on the lower leaves of the tree. The leaves curl and turn brown as they are killed. Although usually confined to the lower leaves of the tree the blight may progress more than halfway up the tree. This disease is most severe on white and bur oak and has not been observed on species of red oak in Iowa.

3. Squirrels and deer-mice frequently girdle branches of oaks by eating the bark around the circumference of young limbs. This injury results in the death of all leaves beyond the point of girdling. Most of the girdling observed has been on large limbs near the apex of the tree and has been most commonly observed on red oak. Girdled branches stand out sharply as a section of dead brown leaves against the rest of the green foliage of the tree. The dead leaves remain on the branches through the summer.

4. Damage from the oak twig girdler is confined to the younger twigs. This insect girdles small twigs under the bark and causes the killing of the apical end. Small flags or patches of dead brown leaves may be seen scattered over the outer perimeter of infested trees. These twig ends break off easily at the point of girdling.

5. Injury by the cicada (17-year locust) results in killing which from a distance may be mistaken for oak wilt. There is a general browning of leaves throughout the tree in severe cases. Close inspection will reveal longitudinal slits in the bark, usually on the lower side of the branches.

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